ILR07

2/10/16

TEAM F: ADD_IN

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Individual Progress

Since the last ILR I have worked simultaneously on both mechanical and software aspects of our project. On the mechanical front, I manufactured Ihsane's designs for a new heat block (Figure 1) and mounting hardware for the nozzle. The nozzle design reduces the volume of molten plastic within the heat block, thereby hopefully improving control over the extrusion rate. Testing has shown that even without the extrusion drive running, molten plastic still 'drools' out of the nozzle and reduces the final print quality. Ihsane performed some preliminary testing of the nozzle but was having issues with filament jams.

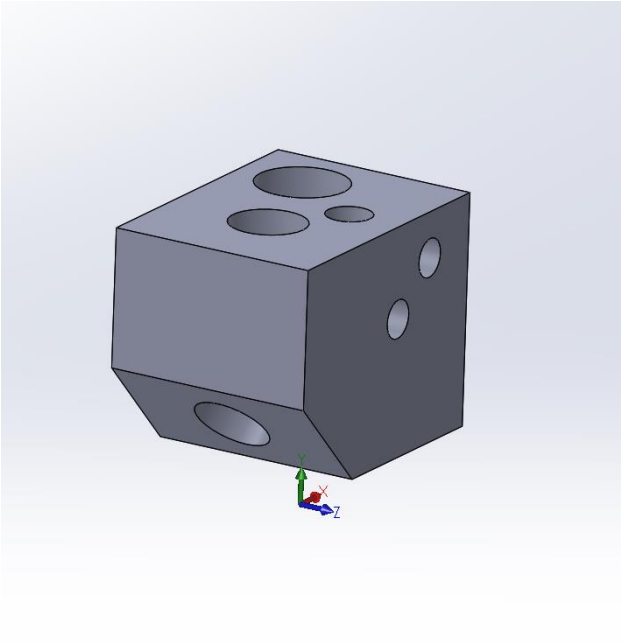

Figure 1: New (smaller) heat block design

I also finalized and manufactured my own (more experimental) design (Figure 2) for a nozzle which if successful further reduces the volume of molten filament and required spacing between COTS items. Unlike Ihsane's nozzle design (which is based loosely on the original MakerGear nozzle), my design has directly heats the extrusion tip (using a custom wound heater) and has an integrated insulator to prevent heat from traveling to upstream filament. For the insulator I manufactured multiple versions using both PTFE and PEEK to evaluate which is more suitable. PEEK is preferable since it is much more rigid, but is slightly less tolerant to high temperatures. Preliminary testing has so far shown it to be sufficient. For the nozzle tip I manufactured two different versions with different tip angles and orifice diameters. With the previous nozzle design a larger orifice tended to give better quality prints, although since this design has such a small heated region the smaller orifice may provide better heat transfer to the plastic. So far I have preformed preliminary testing with the larger orifice version and successfully extruded filament. I am currently waiting on small diameter thermistors to arrive from DigiKey so that I can actively control the nozzle temperature.

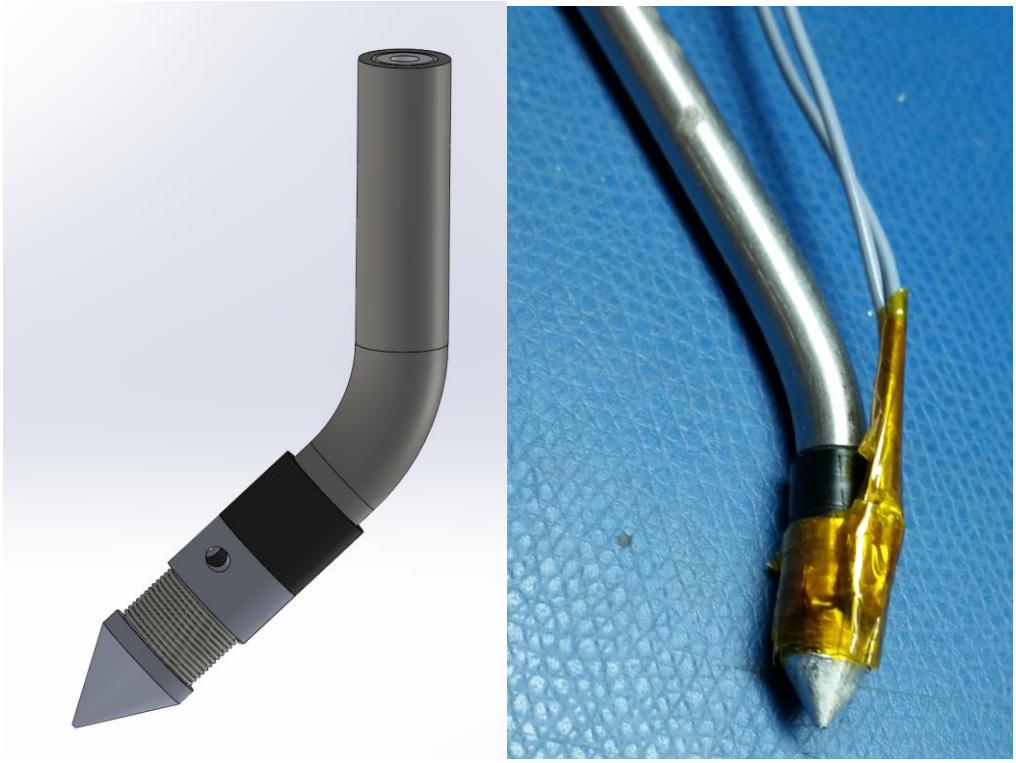

Figure 2: New nozzle design with integrated heater

For software I have worked with Astha to develop an operational GUI (Figure 3) for accessing all of the software features required for our printer. Last PR I created an initial layout for the GUI and Astha and I had developed an object oriented framework that contained all of the layer selection, path planning, and basic visualization tools. This PR period I worked to connect the GUI to our object oriented framework, and improve the COTS item addition process.

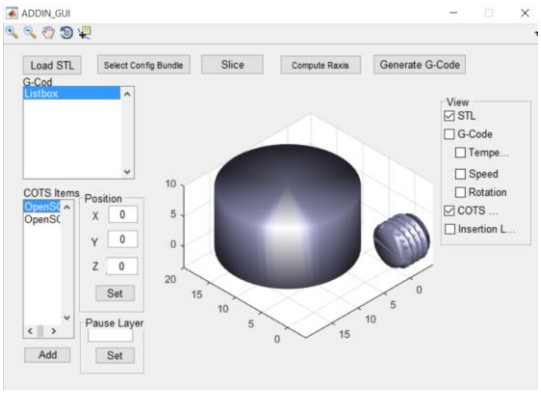

Figure 3: GUI Screenshot

With the current GUI, the user now inputs a COTS item by selecting an .stl file (.stl files are available for most parts on McMaster) which can then be oriented (using the COTS addition popup, Figure 4) and translated relative to the 3D print part. Using an .stl file to define the COTS

item enables a visual check that the item is placed correctly and correctly interfaces with the 3D print part. Minor details such as highlighting the currently selected COTS item and tuning the display's lighting parameters make the visual interface much more user friendly and graphically appealing.

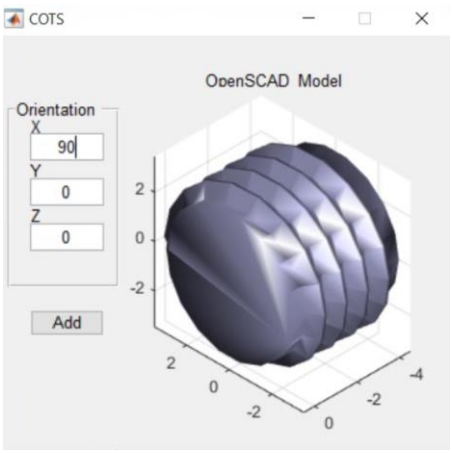

Figure 4: COTS addition pane

Challenges

Machining the components to interface the nozzle to the slip ring and rotary stage proved to be trickier than I had anticipated. Turning and threading a thin walled 6mm OD tube on a 15" lathe without creating a taper was difficult. A follower rest would have been ideal but was not available and on a 15" lathe likely would not be compatible with such a small diameter part. Ultimately I ended up getting access to the CNC lathe and used it to make a custom dead center (with sufficient clearance to allow for tool access) which I used to stabilize the part from both ends.

Machining the components for my nozzle design was also time consuming since each part had numerous small features. Since most of the time was in machine setup I machined a batch of seven insulators and two nozzles to allow for testing, modifications, and mistakes. Winding the custom heater coil was also tedious since the wraps need to not touch (the nichrome wire is uninsulated) and kapton tape needed to be applied between each layer.

Software went smoothly although there still exists minor bugs. Once we begin print testing I will implement a bug tracker so the entire team can report software bugs it encounters while using the ADDIN GUI.

Teamwork

The last two weeks have been a major push for our project. Originally we were hoping to have our printer fully functional by February 3rd, but a combination of ordering delays and firmware bugs have set us back. Fortunately, we still have ample time before the SVE to get our printer running and tested, and intentionally built in a two-week buffer for this type of delay into our

project schedule. To ensure we still meet our deadline Ihsane will be helping Nikhil to debug the firmware.

Astha Prasad worked on software. While I primarily focused on improving the COTS item pipeline, she worked on the G-Code generation and visualization tools. She wrote the functions to integrate the ADD_IN class with Slic3r, and developed visualization tools (shown in Figure 5) to show the temperature and feedrate throughout the print.

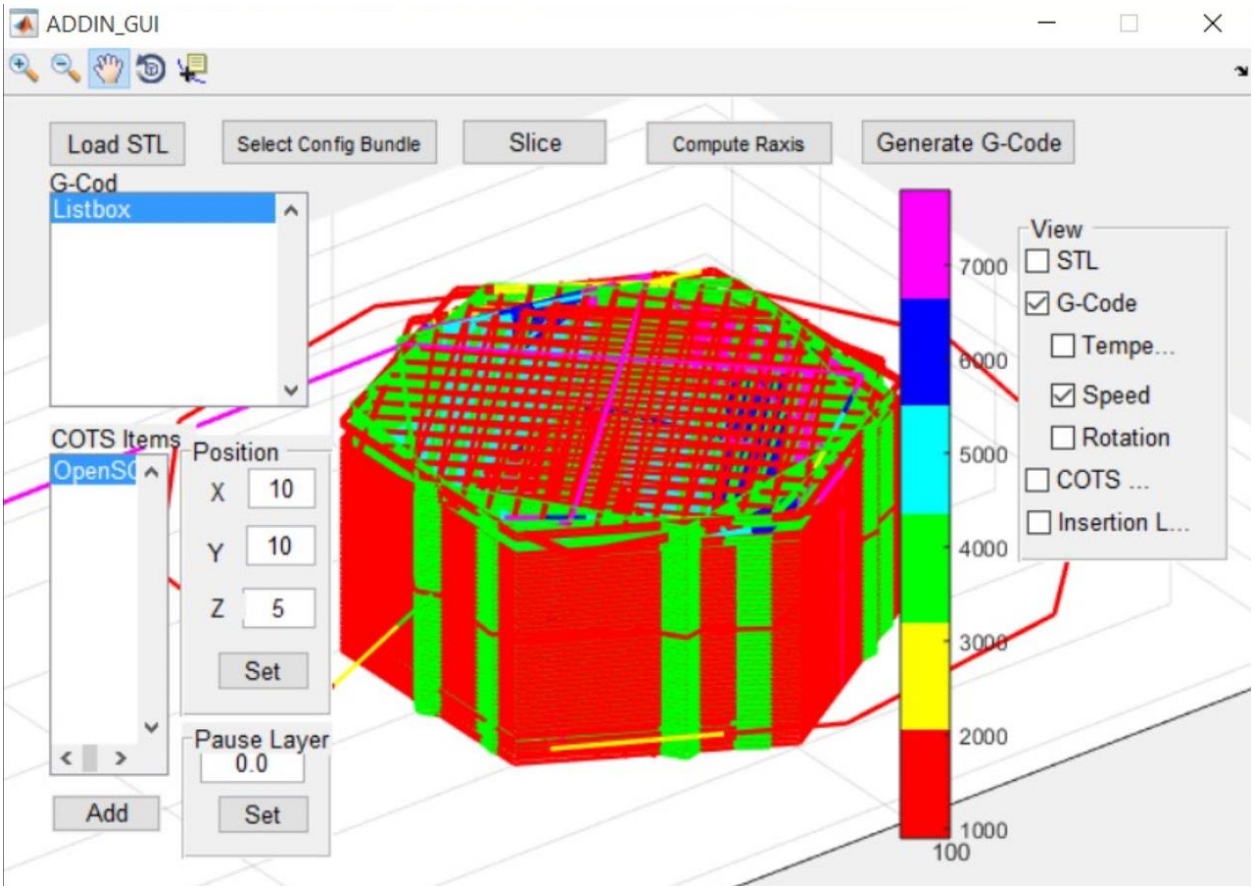

Figure 5: GUI visualizing print speed throughout part

Nikhil Baheti worked on the firmware and resolved the micro stepping issue we encountered during the previous PR. Unfortunately, there still exists some bug which is preventing his firmware from being able to control the 'E1' stepper motor driver which we plan to use for controlling our rotation axis.

Ihsane Debbache worked on setting up our new printer and designing the mechanical interfaces between the rotary joint and the nozzle. He also created a tracking spreadsheet to log the results of the test prints we plan to undertake in the coming weeks.

Future Plans

Our primary focus is getting all subsystems working so that we can start testing printing around COTS items. The only remaining hindrance to this is resolving a firmware bug which both Nikhil and Ihsane are working on.

Astha will have the lead role on software (next step is to develop a collision checking algorithm) as I continue to focus my attention on mechanical aspects. Specifically, I will be iterating on Ihsane's original rotary joint mount design which we are concerned may be too flimsy and may deflect while printing.

Ihsane and I will both be testing the new nozzle designs and determining either can achieve a better print quality than the version we developed during fall semester.